



STATE OF MICHIGAN

INIFER M. GRANHOLM  
GOVERNOR

DEPARTMENT OF CONSUMER & INDUSTRY SERVICES  
LANSING

DAVID C. HOLLISTER  
DIRECTOR

DOCUMENT NUMBER 03-51

*Approved 01/24/03*

August 28, 2003

TO: Members of the Construction Code Commission  
FROM: *[Signature]* Henry L. Green  
SUBJECT: Request for Interpretation

On June 2, 2003, Midwest Cleanroom Associates requested a formal interpretation of the following question. Below the question is a discussion and recommended response for your consideration.

Cleanroom, as defined by NFPA 318, Section 3.3.4: "A room in which the concentration of airborne particles is controlled to specific limits. Cleanrooms include areas below the raised floor and above the ceiling grid if these areas are part of the air path and within the rated construction.

Question: Can fan filter units installed in cleanroom ceiling grids be supplied with flexible cords and plugs for the electrical supply connection as allowed in Section 400-7(a)(8); or, does the installation violate Section 400-8(5) of the 1999 MEC?

Midwest Cleanroom Associates' position is that the space above the grid/suspended ceiling in a cleanroom should not be classified the same as the space above a typical suspended ceiling found in a commercial or industrial facility. This position is based on the contention that the cleanroom envelope does not share any environmental air with the remainder of the building; and, that this position is supported by cleanroom industry practice. (See June 2, 2003 letter to Henry Green).

Section 400-7, Uses Permitted; and 400-7(a) Uses, of the 1999 MEC provides, "Flexible cords and cables shall be used only for the following:

"(8) Appliances where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance and repair, and the appliance is intended or identified for flexible cord connection."

*Providing for Michigan's Safety in the Built Environment*

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August 28, 2003

Answer: Yes, fan filter units may be installed in cleanroom ceiling grids with cord and plug power supply. Fan filter units are designed to comply with UL Standard 507. Section 13.1.1 of the standard requires the power supply of permanently connected appliances to be provided by means of permanent electrical connection. Section 13.1.2 of the standard lists the types of appliances in reference to the requirement being, Section 13.1.2(b), "An appliance intended for permanent attachment to a building structure." Exception No. 3 to this section would allow the use of a power supply cord when specific criteria of the cord has been met. (See the page numbered 37 of UL 507).

- a) Has three conductors;
- b) Is Type SJ or heavier terminating in an acceptable grounding type attachment plug;
- c) Has a length of 0.30 – 3.7m (1-12 feet);
- d) Is permanently attached to the fan;
- e) Complies with the requirements of 14.1.2 and 14.2.1 – 14.2.5; and
- f) Is marked in accordance with 62.1.10 or 111.1

Section 400-8, Uses Not Permitted, of the 1999 MEC provides, "Unless specifically permitted in Section 400-7, flexible cords and cables shall not be used for the following:

"(5) Where concealed behind building walls, structural ceilings, suspended ceilings, dropped ceilings, or floors."

Fan filter units are typically intended for permanent installation by means of a permanent wiring method. However, manufacturers are allowed to provide an optional power supply cord at the customer's request. Additionally, compliance to Section 400-8(5) and 300-22(c)(1) of the 1999 MEC is still required if the units are provided with the supply cord. (See May 27, 2003 letter from UL).



June 2, 2003

Mr. Henry Green, Director  
Bureau of Construction Codes & Fire Safety  
Michigan Department of Consumer & Industry Services  
P.O. Box 30254  
Lansing, Michigan 48909

Re: Request For Michigan Electrical Code Interpret  
1999 Edition, Section 400-8(5), Electrical Outlets Above Ceiling

Dear Mr. Henry:

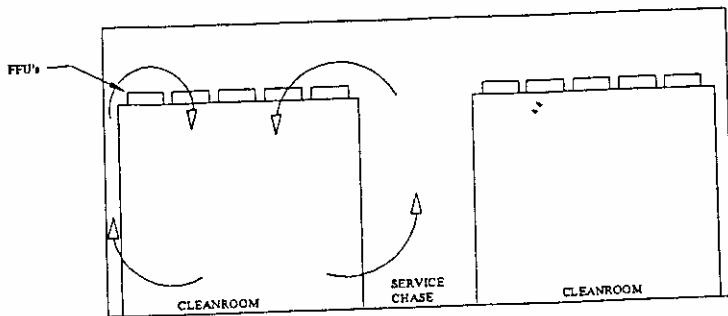
This letter is in response to a violation cited to Edgewood Electric concerning electrical outlets above the ceiling in the newly constructed College of Engineering Cleanroom facility on the Wayne State campus. We request an interpretation of the Michigan Electrical Code, Article 400-8 regarding wiring methods allowed in a facility of this type.

It is our position that the space above the suspended ceiling in a cleanroom should not be classified the same as the space above a typical suspended ceiling found in a commercial or industrial facility. Our position is based on the fact that the cleanroom envelope is completely isolated from all other spaces in the building and does not share any environmental air with the remainder of the building. Our position is supported by general practice in the cleanroom industry.

**In Defense Of Our Position We Offer The Following**

**Background**

It was, and is, the intent of the project team to design and construct the new cleanroom facility in accordance with all applicable codes and standards. Semiconductor fabrication facilities are, by their very nature, complex and expensive to design and build. Semiconductor technology evolves at a rate unmatched by any other industry or technology. This rapid evolution can outpace industry codes and their adoption process. There are literally 100's of codes and standards that must be taken into account when building a project of this nature. Not only must the design comply with the adopted codes in effect at the time of the project, but also Best Engineering Practice demands that the design meet or exceed the intent of the latest issue of the applicable codes. And at the same time, the facility must be productive and meet the life safety and property protection requirements of the enforcement authorities and the end user.



Cleanrooms normally form a large part of semiconductor fabrication facilities. For the cleanroom to be productive, the integrity of the clean envelope must be maintained at all times. If the cleanroom environment or pressure envelope is not maintained, contamination will enter the clean zone. This contamination can result in loss production and can require expensive super cleaning to return the room to production. The cleanroom ceiling, walls and floor form the primary barrier between the "dirty" side and "clean" side of the cleanroom envelope. The fan filter units are just part of the cleanroom ceiling system. By nature of the room criteria, the cleanroom envelope is isolated from other parts of the building with cleanroom partitions and fire rated walls. The envelope is not penetrated with ducts or other air handling plenums common to other areas of the building.

The entire cleanroom envelope is monitored for pressure differential and for smoke using, extremely sensitive smoke detection equipment. The space above the cleanroom ceiling grid is open to the service chases and is an integral part of the service chase. Many of the systems found in typical commercial buildings have been modified or enhanced for use in the cleanroom environment. As an example, special fast response sprinkler heads are used in cleanrooms because of the downward vertical air stream. Air sampling smoke detection systems that respond to very low levels of smoke are also employed in this environment. The clean environment also requires the use of special lighting fixtures that are completely sealed to preclude the introduction of contaminants into the cleanroom. All conduits and piping penetrations are sealed to reduce infiltration and ex-filtration. The interiors of conduits that penetrate the clean envelope are also sealed to preclude the movement of contaminated air.

These are not normal construction practices, and only serve to reinforce our position that the cleanroom envelope is not typical construction. The use of equipment and systems in a cleanroom environment, in ways untypical of normal construction practices, requires the application of the intent of many codes, and not the strict wording of the code language.

As an example, 1999 NEC Section 300.22(C)(1), "Other Space Used for Environmental Air", requires the use of MI, MC or AC cable. But 2000 NFPA 318 8.3 "Electrical Design", para 8.3.1.3 states "Where the air space below a raised floor or above a suspended ceiling is used to recirculate cleanroom environmental air, plenum rated cable shall not be required".

The proper operation and maintenance of the fan filter units is critical for maintaining the pressurization of the cleanroom. The fan filter unit pre-filters and HEPA or ULPA final filters cannot be changed without removing the unit from the ceiling grid. The removal of a fan filter unit and subsequent loss of cleanroom pressurization, will result in increased levels of contamination and loss of processing. This period should be kept to an absolute minimum. It was with this

## MIDWEST CLEANROOM ASSOCIATES

criticality in mind, that the fan filter units were specified with cords and plugs to facilitate their removal and maintenance.

### Codes, Standards and Certifications

The fan filter units provided for this project were manufactured by Gordon. This unit has been tested and certified by UL Labs to UL 507, with the power cord and plug, and has been issued UL listing E204852.

We have attached applicable portions of UL 507 for your review. Section 14, "Power Supply Connections – Cord Connected Appliances", with Table 14.1 which specifies the cord requirements. Section 13, "Power Supply Connections – Permanently Connected Appliances", specifically Exception 3 referenced in Table 14.1.

Michigan Electrical Code, 1999, based on NFPA 70, "National Electrical Code, 1999 Edition" is the adopted code in effect for this project. In addition, the NFPA 318, "Standard for the Protection of Semiconductor Fabrication Facilities, 2000 Edition" was the primary facilities code used in the design of the electrical facilities for this project.

NFPA 70, Article 100, Definitions.

"Appliance" Utilization equipment, generally other than industrial, normally built in standardized sizes or types, that is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, etc.

"Utilization Equipment" Equipment that utilizes electric energy for electronic, electromechanical, chemical heating, lighting or similar purposes.

NFPA 70, Section 400 – Flexible Cords and Cables  
Paragraph 400-7, Uses Permitted.

(a) *Uses Flexible cords and cables shall be used only for the following:*

(3) *Connection of portable lamps, portable and mobile signs, or appliances.*

(6) *Connection of stationary equipment to facilitate their frequent interchange.*

(8) *Appliances where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance and repair, and the appliance is intended or identified for flexible cord connection.*

(b) *Attachment Plugs. Where used as permitted in subsections (a)(3), (a)(6) and (a)(8), each cord shall be equipped with an attachment plug and shall be energized from a receptacle circuit.*

Paragraph 400-8, Uses Not Permitted. *Unless specifically permitted in Section 400-7, flexible cords and cables shall not be used for the following:*

(5) *Where concealed behind building walls, structural ceilings, suspended ceilings, dropped ceilings, or floors.*

This paragraph is only applicable if the intent of paragraph 400-7 is not met. This installation meets the intent of paragraph 400-7. The cleanroom ceiling is open to the service chases, unlike typical suspended ceilings that reach wall to wall, and share environmental air with other spaces.

NFPA 318, Section 8.3, "Electrical Design", paragraph 8.3.1.3 states, *"Where the air space below a raised floor or above a suspended ceiling is used to re-circulate cleanroom environmental air, plenum rated cable shall not be required."*

The use of fan filter units supplied with cords and plugs is common practice in the semi-conductor industry. Fan Powered Filter unit manufacturers report that approximately 50% of the units

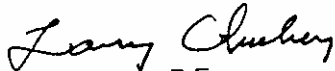
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shipped have a cord and plug. It is our contention that the space above the ceiling grid is a special use space and is common with the equipment support chases. The equipment support chases have all types of support equipment installed in them and the chase is open to the space above the cleanroom ceiling.

We request an interpretation of the applicable sections of the Michigan Electrical Code. The project has changed out the cord and plug assemblies and have removed the receptacles located above the ceiling grid. The interpretation would not change anything for the project in question, but would give us direction for future projects.

If you have any questions on what we are requesting, please contact us at your earliest convenience.

Respectfully Submitted,  
MIDWEST CLEANROOM ASSOICATES



Larry Cluchey, P.E.  
Project Engineer  
616.257.8830

- b) Film-coated wire;
- c) Internal wiring; or
- d) Moving parts.

## 12 Protection Against Corrosion

12.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, plating, or an equivalent means.

*Exception No. 1: This requirement does not apply to a part in which corrosion does not result in a risk of fire, electric shock, or injury to persons.*

*Exception No. 2: This requirement does not apply to the surfaces of sheet-steel and cast-iron parts within an enclosure, when corrosion of the parts due to exposure of the metal to air and moisture is not appreciable – thickness of metal and temperature also being factors.*

*Exception No. 3: This requirement does not apply to bearings, laminations, or minor parts of iron or steel such as washers, screws, and the like.*

## 13 Power Supply Connections – Permanently-Connected Appliances

### 13.1 General

13.1.1 An appliance intended for permanent connection to the power supply shall be constructed so that it may be permanently connected electrically to one of the wiring systems that is acceptable for the appliance in accordance with the National Electrical Code, ANSI/NFPA 70-1999.

13.1.2 With reference to the requirement specified in 13.1.1, the following types of appliances shall be provided with means for permanent electrical connection to the power supply:

- a) An attic fan;
- b) An appliance intended for permanent attachment to a building structure;
- c) A duct-connected appliance; or
- d) A range hood.

*Exception No. 1: An in-wall or in-glass fan not intended to be used in a cooking area is not required to be provided with a means for permanent electrical connection when it is provided with a power-supply cord that:*

- a) Is at least 0.46 m (18 inches) and not more than 3.05 m (10 feet) long;*
- b) Has three conductors, one being the equipment grounding conductor;*
- c) Is Type S, SJ, SJO, SJT, SJTO, SO, SP-3, SPT-3, ST, or STO;*
- d) Is permanently attached to the fan; and*
- e) Complies with the requirements in 14.1.2 and 14.2.1 – 14.2.5.*

### 13.5 Identification

13.5.1 A permanently connected appliance rated 125 volts or 125/250 volts (3-wire) or less, and employing a lamp- or element-holder of the Edison screw-shell type, or a single-pole switch or overcurrent-protective device other than an automatic control without a marked "off" position shall have one terminal or lead identified for the connection of the grounded conductor of the supply circuit. The terminal or lead so identified shall be the one that is electrically connected to the screw shell of a lamp- or element-holder but to which shall not be connected a single-pole switch or single-pole overcurrent-protective device, other than an automatic control without a marked "off" position.

13.5.2 With reference to 13.5.1, if leads from the motor or other component terminate in an attachment plug intended for insertion in a receptacle that is:

- a) Provided as part of the appliance; and
- b) Intended for connection of the branch-circuit power-supply conductors.

The plug and receptacle shall be polarized if a single-pole switch or an Edison-base lampholder is connected to the plug.

13.5.3 A terminal intended for connection of a grounded power-supply conductor shall be made of or plated with metal substantially white in color and shall be readily distinguishable from the other terminals; or identification of that terminal shall be clearly shown in some other manner, such as on an attached wiring diagram.

13.5.4 The surface of a lead intended for the connection of a grounded power-supply conductor shall have a white or natural gray color and shall be readily distinguishable from the other leads.

13.5.5 The surface of a lead intended for connection of an equipment-grounding conductor shall be green with or without one or more yellow stripes, and no other lead shall be so identified.

13.5.6 A terminal intended for the connection of an equipment-grounding conductor shall be identified by:

- a) Use of a wire-binding screw with a green-colored head that is slotted or hexagonal, or both;
- b) Use of a threaded stud with a green-colored hexagonal nut;
- c) Use of a green-colored pressure-terminal connector;
- d) Being marked "G," "GR," "GND," "Ground," "Grounding," the grounding symbol, ⊕, or the like; or
- e) A marking on a wiring diagram provided on the appliance.

## → 14 Power Supply Connections – Cord-Connected Appliances

### 14.1 Cords and plugs

14.1.1 A portable appliance shall be provided with a flexible cord in accordance with Table 14.1 or of a type equally serviceable for the application, and an attachment plug for connection to the power-supply circuit. The length of cord external to the appliance shall be measured from the face of the attachment plug to the point of attachment or entry into the enclosure.

Table 14.1  
Cords for appliances

Table 14.1 effective December 13, 2001

| Appliance  | Type of cord   | Length, m (ft)       |
|--|--|----------------------|
| 1. Fan not intended to rest directly on floor when in use. For example, a bracket fan, window only fan, or portable wall fan mounted with keyhole slots.                 | SP-1, SPT-1  | 1.5 – 3 (5 – 10)     |
| 2. Fan that rests directly on floor when in use, except for the type of fan indicated in item 3. For example, a desk fan, box fan, or household air filtering appliance. | SP-2, SPT-2  | 1.5 – 3 (5 – 10)     |
| 3. Fan intended for commercial or industrial use. For example, a dryer type fan or a commercial air filtering appliance.   | SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400-4 of the National Electrical Code, ANSI/NFPA 70-1999 | 1.5 – 7.6 (5 – 25)   |
| 4. Portable or window-type evaporative cooler.   | SP-2, SPT-2  | 1.5 – 3 (5 – 10)     |
| 5. Commercial, industrial, or agricultural fan mounted as specified in Exception No. 3 of 13.1.2.  | SJ, SJT, SJO, SJTO, or any hard service cord or junior hard service cord in accordance with Table 400-4 of the National Electrical Code, ANSI/NFPA 70-1999 | 0.5 – 3.7 (1.5 – 12) |
| 6. Portable fan employing a general use convenience receptacle.  | SJ, SJE, SJO, SJT, SJTO or equivalent  | 0.5 – 7.6 (1.5 – 25) |

14.1.2 The flexible cord shall be rated for use at a voltage not less than the rated voltage of the appliance, and shall have an ampacity not less than the current rating of the appliance.

14.1.3 The flexible cord shall either be attached permanently to the appliance or be in the form of a separate cord set with acceptable means for connection to the appliance.

14.1.4 An appliance intended for use with a detachable cord set shall not be provided with terminal pins that accommodate a standard flatiron or appliance plug.

14.1.5 The voltage rating of the attachment plug shall not be less than that of the appliance. When an appliance can be adapted for use on two or more different values of voltage by field alteration of internal connections, the attachment plug shall be rated for the voltage for which the appliance is connected when shipped from the factory. See 62.2.2.

14.1.6 The current rating of the attachment plug for an appliance rated 15 amperes or less shall not be less than the current rating of the appliance. For an appliance rated more than 15 amperes, the current rating of the attachment plugs shall not be less than 125 percent of the current rating of the appliance.

14.1.7 The attachment plug of the power supply cord of an appliance provided with a 15- or 20-ampere general-use convenience receptacle shall be of the 3-wire grounding type. The attachment plug of the power supply cord of all other appliances not required to be grounded shall be polarized or of the grounding type.

14.1.8 When a 3-wire grounding-type attachment plug or a 2-wire polarized attachment plug is provided, the attachment plug connections shall comply with Figure 14.1, and the polarity identification of the flexible cord shall comply with Table 14.2.

Exception No. 2: A window fan or desk fan with provision for temporary mounting, such as keyhole slots, is not required to be provided with means for permanent electrical connection when it is provided with a power-supply cord that is permanently attached to the fan and complies with the requirements of 14.1.2, 14.2.1 – 14.2.5, and Table 14.2.

→ Exception No. 3: A wall-mounted, ceiling-mounted, I-beam mounted, or suspension-bracket-mounted fan marked for commercial, industrial, or agricultural use is not required to have provision for permanent electrical connection when provided with a power-supply cord that:

- a) Has three conductors;
- b) Is Type SJ or heavier terminating in an acceptable grounding type attachment plug;
- c) Has a length of 0.30 – 3.7 m (1 – 12 feet);
- d) Is permanently attached to the fan; *STRAIN RELIEF*
- e) Complies with the requirements of 14.1.2 and 14.2.1 – 14.2.5; and
- f) Is marked in accordance with 62.1.10 or 111.1.

Exception No. 4: A down-draft fan is not required to be provided with a means for permanent electrical connection when it is provided with a power supply cord that:

- a) Is at least 457.2 mm (18 inches) but not more than 762 mm (30 inches) long;
- b) Has three conductors, one being the equipment grounding conductor;
- c) Is Type S, SJ, SJO, SJO, SJTO, SO, ST, or STO;
- d) Is permanently attached to the fan at a location intended to be below the surface of the cooking area; and
- e) Complies with the requirements in 14.1.2 and 14.2.1 – 14.2.5.

Exception No. 5: A rangehood is not required to be provided with a means for permanent electrical connection when it complies with the requirements in sub-section 91.6, Cord-connected rangehoods; sub-section 91.7, Rangehood cord-connection kits; sub-section 92.5, Tests for cord-connected rangehoods; sub-section 92.6, Tests for rangehood cord-connection kits; Section 92A, Rating for Cord-Connected Rangehoods; Section 93A, Installation Instructions for Rangehoods and Cord-Connection Kits, and 93.3 – 93.5.